By John W. Kendrick and Carl E. Jones ☆

Gross National Farm Product in Constant Dollars, 1910–50

ESTIMATES of the gross national farm product, introduced in this article, make possible a new evaluation of trends in the farm economy. As the only set of estimates of the gross national product in current and constant dollars originating in a private industry, they also serve to illustrate these concepts and point up the potential significance of the gross product approach for analysis of other industries. The new data also make possible segregation of the nonfarm sector of the private economy for separate analysis when desirable.

For purposes of eliminating the influence of price changes by deflation, the product flow data are essential. Since the gross national product of an industry does not measure value of output, but only value added, price indexes cannot be applied directly to it. Rather, the values of output and of intermediate products, in as fine a product detail as possible, are divided by appropriate prices received and prices paid indexes. The difference between the two deflated totals yields the constant dollar gross national product of the industry.

SUMMARY

The gross national farm product differs in content and movement from measures of the total output of farm products. As a value-added concept, the gross farm product measures only production actually occurring on farms, without duplications. That is, the value of materials used up by farmers in the production process, such as feed, fertilizer, and motor fuel, is deducted from the value of total farm output to arrive at the gross farm product. It is termed "gross" only because depreciation and other capital consumption allowances are not deducted. The value of materials used up in production, technically known as "intermediate products," has risen greatly in recent decades relative to the value of total farm output. Thus, gross farm product has risen significantly less than total farm output over the period 1910–50.

The average annual rate of growth in the real (constant dollar) gross farm product has been about 0.6 percent, approximately one-third the rate of increase in the real value of total farm output. The ratio of real gross farm product to total real gross national product has dropped from almost 11 percent in the pre-World War I period to less than 5 percent in recent years. The current dollar comparison shows less of a drop, due to the large relative increase in prices received by farmers since 1939. The ratio of farm product to total product in current dollars for recent years has been around 9 percent.

Farm labor productivity, as measured by the ratio of real farm product to man-hours worked, has risen by about 1.3 percent a year, as the man-hours worked on farms have declined substantially over the period. When account is taken of the inputs of capital and land as well as labor, the resulting composite farm productivity measure shows a smaller rate of increase than labor productivity alone. Productivity gains have been due mainly to the increasing quantity and quality of farm machinery and equipment, and the progressive application of scientific advances by farm management, resulting in higher crop and livestock yields.

General nature of concept measured

Gross national product originating in farming, or any other single industry, measures the value added by the industry to the products it consumes in production. While "gross" of capital consumption, it is net in the important sense that there is no double counting of products raised by farmers, or purchased from other industries, for use in further farm production.

Industrial gross product can be computed by the "product flow" approach by deducting the value of such purchased intermediate products, charged to current expense, from the value of total output. The result should be the same as that obtained by adding the incomes accruing to the factors of production in the industry—its national income—to nonfactor charges against the total value of output, chiefly indirect business taxes and depreciation.

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Illustration of results

The general concepts and methodology underlying the estimates of gross national farm product in current and constant (1939) dollars are illustrated in the accompanying tables. [1] The estimates of the various components used to arrive at the current dollar national farm product and income are almost entirely those of the Bureau of Agricultural Economics of the U. S. Department of Agriculture (B. A. E.) arranged according to the Department of Commerce concepts. [2]

The basic components of total farm output are shown at the top of table 1. To sales, as represented by cash receipts from farm marketings and Commodity Credit Corporation loans, is added the imputed value of food and firewood consumed on the same farms where they are produced. The

[1] Technical notes describing in detail the derivation of the current dollar estimates and the deflation procedures are available on request. The 1951 "National Income Supplement" to the *Survey* explains the concept of the national income and product originating by industry in greater detail than is possible here.

[2] The underlying B. A. E. data are described in "The Agricultural Estimating and Reporting Services of the U. S. Department of Agriculture."

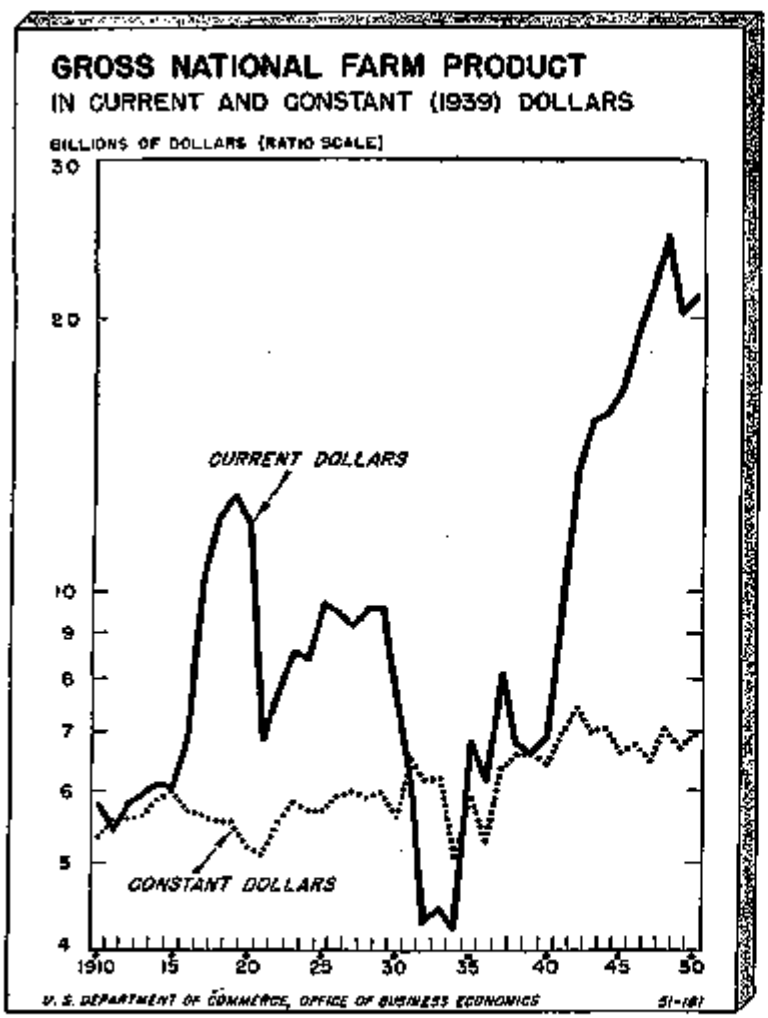
adjustment for the value of the net change in all farm inventories is necessary to convert the sales figures to a commodity output basis. The gross rental value of farm homes is added to obtain the value of total farm output, in accordance with the B. A. E. practice and the Standard Industrial Classification.

The intermediate product deduction from the value of total output consists chiefly of current expenses for feed and livestock, seed, fertilizer, operation of motor vehicles, irrigation, and other purchased items. Purchases by one farmer from another are included, although intermediate products raised and used in further production on the same farm are not included since they do not appear in cash receipts. The bulk of purchased materials represents production, or value added, by nonfarm industries. Gross rents paid to nonfarm landlords, shown separately, are also counted as an expense to farmers, since only the rental value of farm-owned property is considered to originate in the farm sector.

The items which reconcile the gross national farm product with the national farm income estimates, previously published for the period since 1929, are shown separately. The discrepancy is small, since both series are derived from the same basic data, with a few minor exceptions. Due to the previous availability of current dollar farm income estimates, the analysis in this article will center around the constant dollar figures.

The implicit price deflators for the major product flow groupings are shown in table 2. Actually, price deflation was carried out in much greater detail, based largely on B. A. E. indexes of prices received and paid by farmers. The implicit price deflators are the quotients obtained by dividing the sum of the deflated product subgroups into the current dollar total for each group, and thus reflect shifting output and business expense patterns of farmers in addition to price changes.

The constant dollar gross farm product estimates are shown in table 3. The year 1939 was chosen as a base for the sake of consistency with the over-all deflated gross national product estimates contained in the 1951 "National Income Supplement" to the SURVEY OF CURRENT BUSINESS. The base year selected inevitably influences the movement of real farm product to some extent, but the broad conclusions drawn from the 1939 dollar estimates would not be changed.



Source of data: U. S. Department of Commerce, Office of Business Economics, based upon data from U. S. Department of Agriculture, Bureau of Agricultural Economics.

Movements of Gross Farm Products, 1910–50

After adjustment for price changes, the gross farm product has shown a fairly regular upward trend over the past four decades, as can be seen in the accompanying chart. Real farm product has been little affected by the business cycle since changes in the demand situation generally work themselves out, through prices, on farm product in terms of current dollars. To some extent, however, the general level of farm output during the middle 1930's was probably lower than it would have been had effective demand been higher, and certain types of farm production not subject to restrictions.

Occasional erratic year-to-year fluctuations in the volume measure are generally a reflection of unusual weather conditions. For example, the series clearly reflects the influence of the drought years 1934 and 1936, as well as the favorable weather that prevailed during World War II. Partial data indicate that 1951 will see a new record in farm production.

Secular growth of farm product relative to total

Between the two sets of years 1910–14 and 1945–49, real gross farm product increased approximately 20 percent. A straight-line time trend, fitted to the logs of real gross farm product for the years 1910–50, indicates an average annual rate of growth of about 0.6 percent a year. This growth is the product of a slow downward movement in persons and man-hours engaged in farming, and a more than offsetting increase in labor productivity, which will be discussed later.

The growth in real gross farm product has been considerably less than the growth of the total real gross national product. Total real product is estimated to have risen by approximately 175 percent between 1910–14 and 1945–49—an average annual rate of increase of about 3 percent. As a result of the significantly lower rate of growth in the real value added by the farm economy, real gross farm product fell from almost 11 percent of total real gross product in the pre-World War I period to less than 5 percent in the 1945–49 period. This was accompanied by a decline over the same period in the proportion of the United States population living on farms from about one-third to one-sixth.

The ratio of farm to total gross national product in terms of current dollars is close to 9 percent in the recent period, down from 15 percent in 1910–14, but up from 7.2 percent in 1939. The increase in the current dollar ratio in the last decade, in contrast to the continued downward trend of the constant dollar ratio, is due to the much larger rise in the implicit price deflator for gross farm product than in the implicit price deflator for the aggregate measure.

If the real gross farm product had been expressed in terms of a recent price base, such as 1947–49, the increase over the four decades would have been greater than shown by the 1939 dollar measure, and the decline in the ratio to total real gross product somewhat less. This stems from the fact that prices received have been higher in recent years relative

Table 1.—National Farm Product in Current Dollars

Product Flow Estimates, and Reconciliation with National Farm Income

[Millions of dollars]

Item	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928
Total value of farm output	7,514	7,014	7,657	7,847	8,065	8,042	9,266	13,668	16,270	17,262	16,256	9,865	10,901	11,892	12,211	13,474	13,229	12,992	13,685
Cash receipts from farm marketings and CCC loans	5,793	5,596	6,017	6,248	6,050	6,403	7,750	10,746	13,451	14,604	12,606	8,150	8,505	9,563	10,221	10,995	10,564	10,756	11,672
Products consumed on farms where produced	1,177	1,092	1,140	1,153	1,162	1,132	1,309	1,651	2,152	2,395	2,406	1,568	1,646	1,623	1,622	1,781	1,837	1,695	1,066
Net change in all farm inventories	151	−67	96	26	426	73	−266	631	49	−450	348	−613	16	−75	−412	−93	25	−259	136
Gross rental value of farm homes	393	393	404	420	427	434	473	640	618	713	896	760	734	781	780	791	803	800	811
Less: Value of intermediate products consumed, total	1,706	1,595	1,851	1,907	1,954	1,986	2,402	3,237	4,190	4,487	4,397	3,000	3,107	3,362	3,796	3,789	3,745	3,833	4,143
Intermediate products other than rents	1,079	936	1,165	1,204	1,224	1,191	1,442	1,932	2,766	2,892	3,058	1,901	1,968	2,156	2,490	2,532	2,527	2,536	2,843
Gross rents paid to nonfarm landlords	628	659	686	703	730	795	960	1,305	1,424	1,595	1,339	1,099	1,139	1,206	1,306	1,257	1,218	1,297	1,300
Equals: Gross national farm product [1]	5,798	5,419	5,806	5,940	6,111	6,056	6,864	10,431	12,080	12,775	11,859	6,865	7,794	8,530	8,415	9,685	9,484	9,159	9,542
Less: Capital consumption allowances	610	624	647	658	674	700	765	905	1,093	1,349	1,575	1,266	1,146	1,121	1,110	1,104	1,110	1,116	1,123
Depreciation charges	560	574	595	606	620	644	704	826	990	1,235	1,453	1,168	1,058	1,019	1,011	999	1,003	1,007	1,012
Capital outlays charged to current expense	50	50	52	52	54	56	61	79	103	114	122	98	88	102	99	105	107	109	111
Equals: Net national farm product	5,188	4,795	5,159	5,282	5,437	5,356	6,099	9,526	10,987	11,426	10,284	5,599	6,648	7,409	7,305	8,581	8,374	8,043	8,419
Less: Indirect business taxes	150	107	174	200	203	221	237	263	289	359	438	456	460	470	457	478	490	504	515
Equals: National farm income [1]	5,038	4,688	4,985	5,082	5,234	5,135	5,862	9,263	10,698	11,067	9,846	5,143	6,188	6,939	6,848	8,103	7,884	7,539	7,904

Item	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948	1949	1950
Total value of farm output	13,579	11,141	8,690	6,447	6,654	6,723	9,510	9,254	11,450	9,740	9,849	10,476	13,762	19,192	21,942	22,821	24,488	28,256	32,124	36,127	31,153	33,243
Cash receipts from farm marketings and CCC loans	11,908	9,023	6,374	4,747	5,315	6,333	7,095	8,370	8,857	7,697	7,889	8,357	11,190	15,391	19,440	20,371	21,506	24,964	30,014	30,544	28,012	28,773
Products consumed on farms where produced	1,094	1,537	1,254	1,009	1,023	1,090	1,321	1,378	1,410	1,283	1,244	1,254	1,460	1,798	2,183	2,301	2,256	2,624	3,086	2,936	2,610	2,344
Net change in all farm inventories	−252	−249	+306	+34	−271	−1,317	+478	−1,111	+545	+140	+97	+240	+458	+1,309	−420	−645	−148	−237	−2,206	+1,313	−720	+762
Gross rental value of farm homes	829	830	751	656	587	618	616	615	638	620	619	625	654	694	739	794	874	905	1,230	1,334	1,251	1,364
Less: Value of intermediate products consumed, total	4,018	3,541	2,651	2,128	2,203	2,484	2,726	3,055	3,337	2,969	3,231	3,580	4,230	5,640	6,590	7,074	7,720	8,896	10,725	11,642	10,762	11,916
Intermediate products other than rents	2,711	2,394	1,776	1,421	1,478	1,699	1,862	2,089	2,378	2,082	2,240	2,750	3,100	4,213	5,011	5,422	5,988	6,872	8,307	9,078	8,475	9,389
Gross rents paid to nonfarm landlords	1,307	1,147	875	707	725	785	864	966	959	887	991	830	1,130	1,427	1,579	1,652	1,732	2,024	2,418	2,564	2,287	2,527
Discrepancy	90	134	168	162	80	82	64	52	51	41	31	−198	−94	−130	−170	−25	−60	−206	−216	−83	+81	+163
Equals: Gross national farm product	9,471	7,466	5,871	4,157	4,371	4,155	6,731	6,147	8,062	6,730	6,587	7,094	9,626	13,681	15,522	15,772	16,828	19,566	21,616	24,568	20,310	21,164
Less: Capital consumption allowances	1,155	1,111	946	803	730	757	790	849	939	939	968	973	1,098	1,266	1,420	1,558	1,744	1,897	2,334	2,816	3,214	3,510
Depreciation charges	1,043	1,004	852	722	654	676	703	757	840	844	875	876	986	1,133	1,261	1,382	1,563	1,686	2,115	2,570	2,971	3,260
Capital outlays charged to current expense	112	107	94	81	76	81	87	92	99	95	93	97	112	133	159	176	181	211	219	246	243	250
Equals: Net national farm product	8,316	6,355	4,925	3,354	3,641	3,398	5,941	5,298	7,123	5,791	5,619	6,121	8,528	12,415	14,102	14,214	15,084	17,669	19,281	21,752	17,096	17,654
Less: Indirect business taxes	525	519	467	403	351	341	347	365	369	366	373	362	387	416	422	443	404	533	610	664	715	762
Plus: Government payments to farm landlords	0	0	0	0	112	397	498	260	314	412	705	670	514	610	590	715	596	685	278	222	161	239
Equals: National farm income	7,791	5,836	4,458	2,951	3,402	3,454	6,092	5,193	7,068	5,837	5,951	6,429	8,655	12,609	14,270	14,486	15,276	17,821	18,949	21,310	16,542	17,131

[1] Since the total discrepancy between gross national product estimates built up by the income and product approaches prior to 1929 is entirely minor, it has not been shown, but is implicitly included in the national farm income figures. Government payments to farm landlords are also not shown in the stub for the earlier period, since those payments first began in 1933.

Source: U. S. Department of Commerce, Office of Business Economics, based largely upon data from U. S. Department of Agriculture, Bureau of Agricultural Economics.

to prices paid than in 1939. Thus, a smaller weight would have been given to intermediate product purchases relative to the value of output, accentuating the rise in real product.

Part of the decline in the relative size of the farm economy has been due to the fact that the demand for farm products has not increased as rapidly as has total demand, in real terms. Part of it has been due to the fact that the farm economy has come to rely on the nonfarm economy for intermediate products to an increasing extent, relative to the total output of farm products.

Farm output up more than farm product

The increase of 20 percent in real gross farm product between 1910–14 and 1945–49 contrasts with a rise of 60 percent in the real value of total farm output. (See table 1 and the second chart.) The difference between the two measures is due to the very large increase in purchases of intermediate products, which will be discussed in the next section. This section will deal with the nature of the changes in total farm output.

The real value of output of farm commodities alone increased by 65 percent over the period. The difference between the total output and commodity output is accounted for by the gross rental value of farm homes, which increased by only 16 percent over the period in real terms.

Most discussions of farm output relate to the physical volume of total farm commodity output, or of gross sales, without a deduction for intermediate product purchases, and therefore show the larger increase than real gross farm product. The B. A. E. index of "farm output" which is roughly comparable with the deflated commodity output, likewise shows an increase of almost 65 percent over the 35-year period.

Deflated sales are equal to the real value of total commodity output less the net change in farm inventories, valued in constant prices. Since there was a small accumulation of inventories between 1910 and 1914, and a moderate liquidation between 1945 and 1949, deflated sales show a larger increase over the period amounting to almost 70 percent. This movement is roughly corroborated by the B. A. E. index numbers of the "volume of agricultural production for sale and consumption in the farm home" which rose about 66 percent. The correspondence is not precise, since the two series, while covering the same area, involve somewhat different weighting systems.

The "sales" figure includes not only marketings, but also the imputed sales value of food and firewood consumed on the farm where produced. The imputed items have declined by almost 5 percent over the period, in real terms. Since

farm population has declined more than this, per capita home consumption has risen. In relation to total sales, home consumption has fallen from 17 percent in 1910–14 to less than 10 percent in 1945–49.

Cash receipts from farm marketings and CCC loans increased 85 percent over the period. The changing pattern of farm production is revealed by the detailed marketings data, in constant dollars. Total crops showed a somewhat smaller gain than did livestock and livestock products. Oil-bearing crops, vegetables, fruits and nuts, and tobacco showed large gains. Food grains and feed crops showed smaller-than-average increases. Within the livestock group, poultry, eggs, and dairy products showed much larger gains than meat animals, although meat animals are still the most important branch of farm production in terms of the relative value of marketings.

Increase in Purchased Products

During the 35-year period under review, while real gross output rose 60 percent, the real value of intermediate products consumed rose 260 percent. The ratio of intermediate products to gross output, both measured in 1939 dollars, increased from 23 percent in the 1910–14 period to approximately 43 percent in the 1945–49 period. This increase in the intermediate product ratio explains the difference between the 20 percent increase in real gross farm product and the 60 percent rise in the real value of total farm output. (See chart.)

Some intermediate products are direct purchases by one farmer from another. But the bulk are products originating in other industries, as in the case of motor fuels, or farm products which have undergone additional processing and handling in other industries as in the case of commercial feeds and seeds.

Increasing influence of mechanization and science

The large relative increase in purchases of intermediate products by farmers can be traced mainly to the trends towards farm mechanization and scientific management. Mechanization has required increasing expenditures for motor fuel, electric light and power, and maintenance of motor vehicles and other machinery. The unit volumes of these products show a larger percentage increase in recent decades than any other types of purchased goods and services. Expenditures for operation of motor vehicles are now the second largest current expense item. Purchased electricity, while still not a major expense item, has shown a tremendous growth, paralleling the progress of farm electrification.

The increasing application of scientific advances in farm management is at the root of the other large increases in intermediate product purchases. Real outlays for commercial feeds, seeds, fertilizer and lime, insecticides, veterinary services and medicines all increased much more than the physical volume of farm output. Purchases of feed are still the largest single current farm expense, and within this category commercial feeds have become increasingly important. These scientifically balanced animal rations, based on various nonfarm ingredients as well as feed grains, are particularly important in the poultry and dairy branches of agriculture. The commercial seed business has also grown rapidly as a result of the increasing use of cover crops and new varieties of grains, especially the hybrid types.

Commercial fertilizers and lime have been applied on an increasing scale in order to offset soil depletion and support higher yields. Real purchases of insecticides have risen markedly for use in control of pests. Greater expenditures for veterinary services and modern medicines have helped raise production of livestock and livestock products.

Table 2.—Implicit Price Deflators for National Farm Product by Major Components

(1939=100)

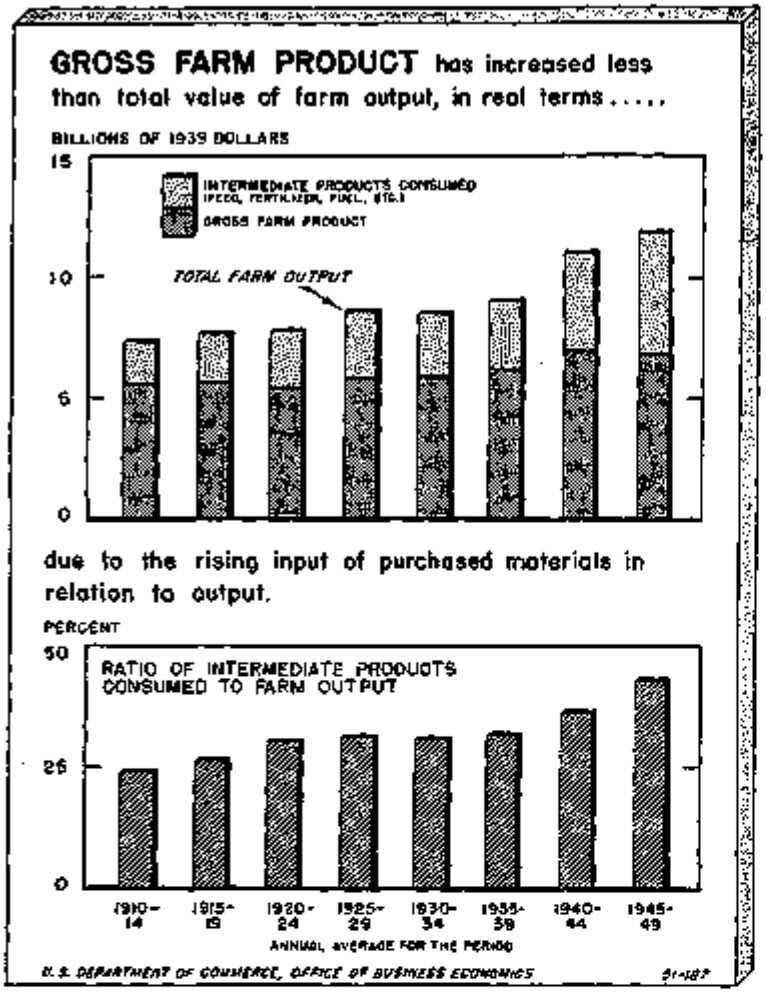
Item	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928
Total value of farm output	106.0	97.2	103.7	104.9	104.5	103.0	121.2	179.2	206.6	220.4	214.7	133.2	137.7	144.8	147.0	163.2	160.3	149.0	156.1
Cash receipts from farm marketings and CCC loans	110.3	100.7	107.4	109.2	109.7	107.0	129.7	192.7	222.2	234.6	224.7	133.7	138.5	146.4	149.3	166.2	164.6	150.5	159.7
Products consumed on farms where produced	99.2	93.7	99.7	100.5	100.3	98.9	114.3	160.2	182.2	190.6	203.2	127.4	128.6	141.4	139.5	152.9	155.3	145.7	150.5
Net change in all farm inventories [1]																			
Gross rental value of farm homes	68.6	69.4	70.6	72.3	73.5	72.7	78.2	87.7	93.7	112.3	138.7	118.0	116.3	124.4	124.2	136.6	127.6	125.8	127.9
Less: Value of intermediate products consumed, total	97.6	97.6	102.3	103.0	105.6	110.0	134.8	162.7	180.2	195.9	185.6	129.2	132.0	141.8	146.3	146.2	140.1	140.5	144.8
Intermediate products other than rents	92.1	89.4	90.3	97.1	99.7	102.0	113.0	143.3	167.7	181.1	185.1	120.2	120.1	130.5	132.6	138.1	131.5	129.9	137.7
Gross rents paid to nonfarm landlords	108.9	112.3	114.5	114.0	117.2	124.6	148.1	197.7	220.7	229.8	188.8	148.3	159.3	170.8	182.1	172.2	169.0	167.4	152.9
Equals: Gross national farm product	103.7	97.2	104.2	105.5	104.1	100.9	120.2	166.4	217.7	230.6	228.9	136.2	140.2	146.8	147.3	169.6	169.9	152.9	161.6

Item	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948	1949	1950
Total value of farm output	153.9	132.5	94.5	73.3	75.0	87.6	112.3	114.0	123.2	102.6	100.0	104.9	128.3	164.9	193.1	196.5	214.5	239.3	274.6	294.1	256.3	261.3
Cash receipts from farm marketings and CCC loans	157.6	132.5	93.2	70.3	73.8	92.0	113.7	110.8	127.6	102.5	100.0	105.1	130.5	167.0	201.2	204.5	216.5	244.7	291.4	301.2	263.3	268.1
Products consumed on farms where produced	151.8	133.1	100.9	82.6	79.5	90.9	114.4	118.7	122.6	105.8	100.0	104.8	128.4	162.0	204.8	190.0	209.9	227.4	262.5	270.8	237.7	237.1
Net change in all farm inventories [1]																						
Gross rental value of farm homes	130.1	120.5	113.0	103.3	94.4	100.3	101.2	101.0	104.6	101.1	100.0	99.6	102.7	108.6	115.6	123.2	130.4	154.7	184.0	196.3	192.7	191.0
Less: Value of intermediate products consumed, total	141.0	130.4	98.7	81.4	83.0	96.5	103.7	108.4	114.0	101.4	100.0	100.5	112.2	135.2	151.2	158.4	162.1	170.0	203.5	221.1	196.4	207.1
Intermediate products other than rents	135.4	122.0	97.8	81.0	82.4	90.2	106.3	107.6	116.5	102.9	100.0	102.9	109.2	127.9	143.8	150.3	153.4	165.0	189.8	208.4	187.7	194.3
Gross rents paid to nonfarm landlords	157.5	155.3	100.7	80.5	84.1	91.4	99.0	110.4	110.1	98.0	100.0	93.7	126.3	162.2	180.0	192.5	201.4	232.6	271.7	282.2	251.0	273.5
Discrepancy [2]																						
Equals: Gross national farm product	159.6	135.5	92.7	69.9	71.7	83.3	114.7	116.9	127.1	103.3	100.0	107.4	127.1	161.6	219.2	223.6	252.2	285.6	323.9	303.9	306.1	

[1] The price deflator implicit in the net change in farm inventories segment is now shown. Minor price movements can produce large fluctuations in the ratio of the net change in current dollars to the net change in the corresponding constant dollar series. Accordingly, the implicit price deflator would have no meaning as an indicator of price movements.

[2] To this variable was applied the price deflator implicit in the gross national farm product without adjustment for discrepancy—thus, the same deflator shown for line 10.

Source: U. S. Department of Commerce, Office of Business Economics.



Source of data: U. S. Department of Commerce, Office of Business Economics, based upon data from U. S. Department of Agriculture, Bureau of Agricultural Economics.

Improved management has paid off

It is noteworthy that the largest increases in purchases of intermediate products relative to gross output have come in periods when prices received by farmers, relative to prices paid, were favorable, especially during and immediately following the two World Wars. It is in such periods that increased outlays for intermediate products seem most assured of paying off in the form of higher net receipts. In a real sense, the relative increase in intermediate product purchases has paid off in that the real value added in the farm economy has gradually increased, over and above the intermediate product input.

If capital consumption allowances in constant dollars were likewise deducted from the real value of output, the trend of real net farm product would not be significantly different from that of the gross measure, except in the post-World War II period. Due to the large farm equipment expenditures of recent years, the real net farm product is not so high as the gross measure relative to prewar levels.

Farm Productivity

Measures of productivity in an industry are usually derived from the relationship between the physical volume of output and the physical volume of input of one or more of the factors of production. As such, they give an indication of the changes in efficiency of the factors of production in the industry. Comparisons can be made with productivity trends in other industries, and in the economy as a whole. Thus, the relative contribution of the industry to the growth of over-all productivity, which is the chief basis of rising standards of living and national economic strength, can be assessed.

Utility of measure used

Most conventional productivity indexes have used some measure of the unit volume of total output as the numerator of the productivity ratio. From the point of view of resource use in the economy as a whole, however, use of the real gross product of the industry as the numerator is preferable. Just as the gross products of all the industries in the economy add up to the total gross national product, so industrial productivity measures based on the real product approach can be combined to yield, or equal, the measure of productivity in the economy as a whole. It is the deduction from the outputs of each industry of the purchases of intermediate products from other industries that eliminates duplication from the resulting product and productivity measures, and makes it possible to combine them.

The conventional productivity measures usually employ a measure of labor input as the denominator of the productivity ratio. Labor is the most important factor of production in most industries, so particular interest attaches to measures of "labor productivity." But since output is a function of the quantity and quality of all the factors of production, such a measure reflects changes in the quantity of the other factors relative to labor input, as well as changes in the joint efficiency of all factors. Therefore, in addition to measuring farm productivity as the ratio of real gross farm product to labor input, we shall also present a measure using composite factor input as the denominator.

Ratio of real farm product to man-hours worked

A Bureau of Agricultural Economics series on man-hours worked was used in the labor productivity computations, since changes in the average hours worked per year are reflected, as well as changes in the numbers of persons engaged. The series relates to all types of farm workers—proprietors and unpaid family workers, as well as hired hands—but is expressed in terms of man-equivalent hours. The man-hours estimates were calculated on the basis of man-hour requirements for the various types of farm production by States, beginning in 1919, combined to yield a national total, and on a U. S. basis 1910–1918. The series is annual, although the benchmark field surveys to which they are tied were made less frequently.[3]

The man-hours worked series shows the same general trend as the B. A. E. employment estimates, based on census and sample survey material. There is evidence of only a mild downward trend in the average hours worked per year since World War I. This result is not unreasonable since available evidence indicates that increasing mechanization has not reduced the farm work-year as much as has been the case in nonfarm industries. Actual average hours worked may have increased in certain periods due to the possibility of using tractors more intensively than draft animals. And the relative increase in certain types of farm enterprises, such as poultry and dairying, may have spread work more evenly over the year. In any case, the productivity trend obtained by using man-hour labor input is similar to that which would be obtained by using farm employment as the denominator, and is conceptually superior.

The upper panel of the chart on productivity shows the index numbers of real gross farm product per man-hour on

[3] For a more detailed discussion of this series, see U. S. Department of Agriculture Technical Bulletin No. 1020, December 1950, "Gains in Productivity of Farm Labor," by Reuben W. Hecht and Glen T. Barton.

a logarithmic scale. A straight-line time trend, fitted to the logarithms of the index numbers indicates an average annual rate of increase of almost 1.3 percent.

This rate of growth in farm labor productivity is somewhat less than prevails in the private nonfarm economy, which is computed to be almost 2.0 percent.[4] If the real value of farm commodity output had been used as the numerator of the ratio, the productivity increase would have averaged more than 3 percent a year. However, if interest is centered on the net contribution of the farm economy, the measure which excludes intermediate product purchases is the more meaningful one.

Composite productivity in farming

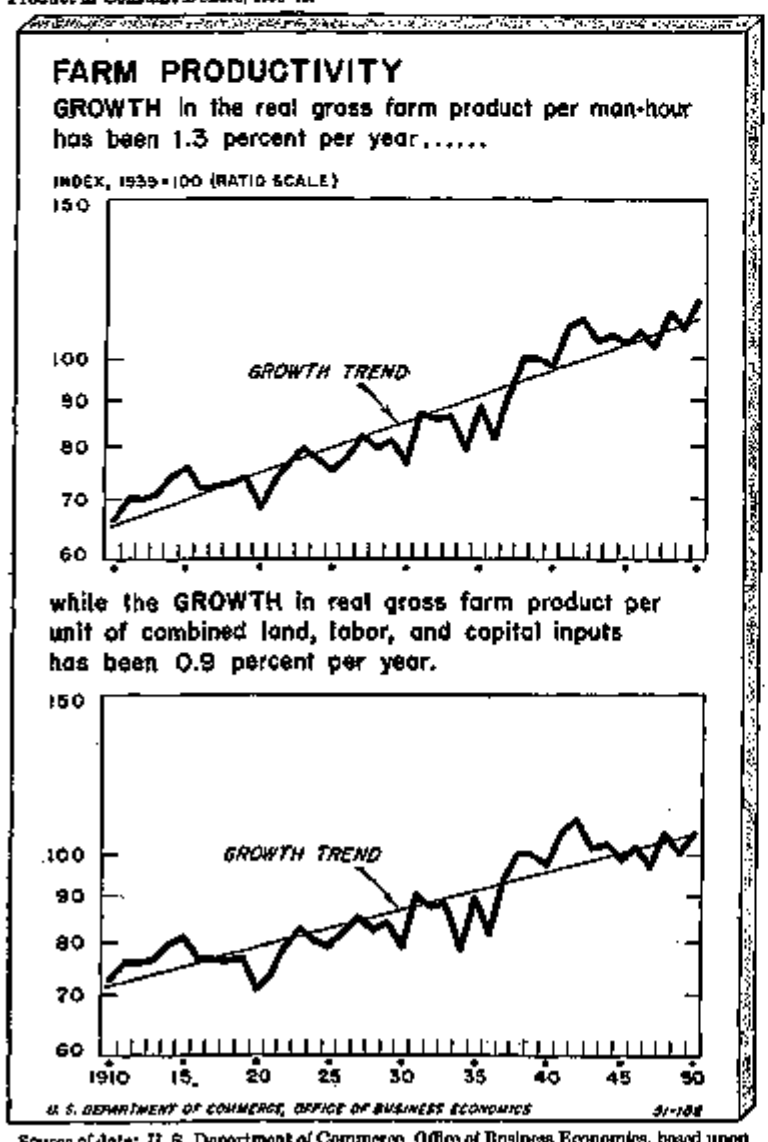
Since capital and land also enter the productive process, it is worthwhile to attempt to measure the quantities of these factor inputs over the period covered. When the other factors are combined with labor input and divided into real product, a conceptually more precise measure of changes in the joint efficiency of the factors of production in farming emerges.

The real value of durable capital assets was derived from B.A.E. estimates of the total value of such assets by major types in the base period, moved by cumulating the net additions in constant (1939) dollars by major types. Net additions were obtained by deflating the B.A.E. current dollar estimates of gross capital outlays and annual depreciation charges by appropriate price indexes from the same source, and taking the differences.

It is clear that in any one year, the assumed depreciation derived from conventional depreciation rates applied to the existing capital at the beginning of the period is only an approximation to actual physical wear, tear, and obsolescence. Over a period of years, however, it should result in a fair approximation to capital consumption. Estimates of the constant dollar value of total farm inventories involved only the cumulation of the net change, in constant dollars, from the base period total value.

The constant dollar value of farm land was obtained by moving the total value in the base period by the acreage of farm lands as reported by the Census of Agriculture. This series, which does not reflect the effect of shifts among different types of land of varying relative value, has increased by more than one-fourth over the four decades. Since most of the increase has come not in cropland, but in relatively lower value pasture land, the real increase was probably less, although data are not at hand to refine the estimates.

[4] See the January 1951 Survey of Current Business, "Estimates of Gross National Product in Constant Dollars, 1929–49."



Source of data: U. S. Department of Commerce, Office of Business Economics, based upon data from U. S. Department of Agriculture, Bureau of Agricultural Economics.

Capital assets up a fourth

During the period between 1910–14 and 1945–49, the real value of reproducible farm capital assets increased by almost one-fourth. Within the category, trends are divergent. Farm inventories showed little net change over the period, as the steady decline in numbers of horses and mules offset a net increase in the inventory items other than work stock. Farm structures increased by less than 10 percent.

The big increase came in farm machinery and motor vehicles, which rose by almost 120 percent. The farm machinery portion increased by almost 50 percent, while the real value of motor vehicles climbed from a negligible quantity at the beginning of the period to more than one-third of the combined constant dollar value of the subgroup. The trend in the real value of motor vehicles is roughly paralleled by the increase in numbers. In contrast to negligible numbers prior to World War I, by 1949 there were 5.3 million automobiles on farms, use of which is partly for business purposes, 3.5 million tractors, and 2.1 million trucks.

The computations of the real value of farm capital assets and land are approximations, but the important fact is established that the quantities of capital and land per unit of labor input increased significantly over the period. The index numbers of the three types of factor input were combined by the relative income accruing to labor, capital and land in the period 1940–49, when demand was at a generally high level. Labor income (including the imputed wages of farm proprietors, as distinct from their net land rents and profits) accounted for about two-thirds of the total. The remaining portion split almost evenly between capital return and net land rents.

Trend in composite productivity

Real gross farm product divided by composite factor input is shown in the lower panel of the chart. Since labor input is the dominating factor, the year-to-year fluctuations appear similar to those in the farm labor productivity curve. However, the trend line fitted to the logs of the composite productivity index numbers shows a significantly smaller rate of increase—0.9 percent a year—compared with 1.3 percent in the case of farm labor productivity. This lower trend is the corrolary to the fact that combined real property input per man-hour in farming increased by more than 60 percent over the period. If land input actually increased less than the measure used in this computation, the true productivity ratio would show a somewhat larger rate of increase.

Table 3.—National Farm Product in Constant Dollars

[Millions of 1939 dollars]

Item	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928
Total value of farm output	7,020	7,219	7,384	7,451	7,739	7,808	7,636	7,629	7,675	7,651	7,671	7,399	7,914	8,219	8,309	8,303	8,464	8,720	8,758
Cash receipts from farm marketings and CCC loans	5,290	5,559	5,602	5,721	6,018	5,894	5,977	5,677	6,058	6,224	6,611	6,096	6,204	6,532	6,846	6,610	6,834	7,147	6,977
Products consumed on farms where produced	1,186	1,166	1,143	1,147	1,158	1,169	1,140	1,169	1,181	1,216	1,134	1,141	1,154	1,146	1,163	1,167	1,158	1,163	1,107
Net change in all farm inventories	87	−61	69	92	417	88	−92	267	10	−243	136	−476	−85	−95	−327	−109	−48	−221	40
Gross rental value of farm homes	457	565	572	631	569	597	605	616	626	652	640	630	631	628	626	629	630	631	634
Less: Value of intermediate products consumed, total	1,747	1,634	1,809	1,852	1,851	1,806	1,924	1,900	2,325	2,291	2,369	2,322	2,364	2,371	2,595	2,691	2,674	2,728	2,863
Intermediate products other than rents	1,172	1,047	1,210	1,240	1,228	1,169	1,276	1,230	1,649	1,597	1,652	1,581	1,650	1,666	1,878	1,961	1,922	1,953	2,064
Gross rents paid to nonfarm landlords	575	587	599	612	623	638	648	660	676	694	717	741	715	705	717	730	752	775	798
Equals: Gross national farm product	5,332	5,576	5,577	5,629	5,848	6,002	5,712	5,639	5,654	5,540	5,282	5,077	5,550	5,842	5,714	5,712	5,930	5,992	5,896

Item	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948	1949	1950
Total value of farm output	8,521	8,409	9,138	8,736	8,887	7,667	8,646	10,130	9,297	9,451	9,639	9,904	10,487	11,439	11,367	11,643	12,419	11,808	11,700	12,284	12,134	12,720
Cash receipts from farm marketings and CCC loans	7,173	6,783	6,830	6,757	7,199	6,941	6,241	6,691	6,939	7,410	7,679	7,839	8,572	9,217	9,671	9,858	9,936	10,163	10,300	10,140	10,037	10,734
Products consumed on farms where produced	1,119	1,113	1,170	1,221	1,282	1,189	1,155	1,158	1,150	1,213	1,244	1,197	1,137	1,104	1,056	1,108	1,070	1,104	1,179	1,094	1,036	1,032
Net change in all farm inventories	−106	−138	+650	+135	−736	−997	+540	−638	+648	+155	+97	+232	+341	+609	−9	−191	−219	−151	−442	+377	−240	+240
Gross rental value of farm homes	637	641	638	633	622	614	609	609	610	613	619	628	627	659	658	634	637	643	653	683	701	714
Less: Value of intermediate products consumed, total	2,832	2,801	2,085	2,614	2,555	2,672	2,629	2,417	2,913	2,918	3,230	3,661	3,727	4,173	4,368	4,405	4,770	5,086	5,271	5,260	5,426	5,765
Intermediate products other than rents	2,002	1,253	1,810	1,736	1,793	1,712	1,750	1,051	2,042	2,033	2,340	2,875	2,840	3,253	3,486	3,607	3,910	4,165	4,381	4,231	4,514	4,831
Gross rents paid to nonfarm landlords	830	848	800	876	802	658	873	860	871	885	891	886	887	890	873	858	890	671	890	995	911	924
Discrepancy	33	93	180	235	116	67	48	45	41	52	21	−172	−61	−76	−77	−11	−33	−73	−64	−24	+20	+64
Equals: Gross national farm product	5,934	5,516	6,133	5,347	6,096	4,939	5,868	5,258	6,843	6,621	6,587	6,606	7,431	7,534	7,083	7,454	6,673	6,646	6,493	7,643	6,708	6,611

Source: U. S. Department of Commerce, Office of Business Economics.

It might be objected that from the production angle, the real gross rental value of farm dwellings should not be counted as farm product, and that real gross rents paid to nonfarm landlords should be counted as originating in farming, since the capital and land on which the rents are paid are employed in the farm production process. To some extent, the two items are offsetting. To the extent, they are not, the movements of the real farm product and productivity based on the alternative concept are but little different, and show only a slightly higher time trend. The data in table 3 make possible the alternative computation.

Reasons for farm productivity gains

The root of increasing productivity, or efficiency of the factors of production, lies primarily in advancing knowledge, the application of that knowledge to production equipment and processes, and the spreading adoption of improved technologies. In farming as in other industry, productivity gains are closely related to increasing expenditures of time and money for research and development activities, and the rate of adoption of new methods and machines by farmers as a result of formal or informal educational activities. The research, development and educational activities may or may not originate within the industry itself.

Technological changes in farming can be grouped under three heads: improvements in land utilization designed to offset or reverse the tendency towards declining quality of land; improvements in capital through the introduction of new types and models of machinery, equipment and plant; and improvements in the quality of farm labor (largely management) as evidenced not only by adoption of, and adaptation to, improved land and capital technology, but also by the adoption of better crop and livestock production processes, and organization of the farm enterprise generally. It is impossible to isolate the contribution of each of the factors to the over-all increase in productivity, but a few of the outstanding technological advances can be mentioned.[5]

[5] A recent review of technological advances in farming is the U. S. Department of Agriculture Miscellaneous Publication No. 707, "Changes in American Farming," by Sherman E. Johnson, December 1949.

Farming differs from non-extractive industries in that some of the technological advances are required to offset a tendency towards deterioration in the quality of land as soils are depleted and farming is extended to inherently less productive lands. In recent years, crop rotation systems, contour farming and terracing, and use of green-manure crops as well as fertilizer and lime have become increasingly prevalent.

Increases in efficiency of farm producers' durable equipment have been striking. The period under review encompasses the rise of the mechanical-power phase of the revolution in farm machinery which began more than a century ago. This has been associated with the replacement of horses and mules by tractors which have been improved steadily in usefulness. Other types of farm machinery have also been improved greatly in speed, durability, economy and other respects. Most types have been redesigned for integral use with tractors, and completely new types introduced. The contribution of the automobile and truck to speeding up the transportation job both on the farm, and from farm to market, is also significant.

Farm management and labor have likewise increased in efficiency. Not only have they increased their skills with regard to use of farm equipment and in land utilization practices, but they have adopted various other scientific advances which have increased farm production relative to factor input. Improved varieties of crops, such as hybrid corn, have increased crop yields. Improved breeding and feeding of livestock have increased the output of animal products per unit of input. Pests, and animal and crop diseases, have been subject to greater control. In some cases, changes in the size and organization of the farm have reduced overhead charges per unit of output.

The record of farm productivity gains is a significant one. As in the past, it is the growth in farm productivity which makes possible the diversion of an increasing proportion of the resources of the economy to nonfarm production, with a consequent continuation of the upward trend in standards of living which has characterized the American economy.